Evaluation of the Flexural Strength of Glass Ionomer Dental Cement Modified Using Phytomedicine

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Abstract

Background: To evaluate flexural strength of glass ionomer cement modified with phytomedicine. **Materials & Methods:** A total of 40 samples were enrolled. Ethyl alcohol was used to extract leaves from Salvadora persica, and Olea europaea using a Soxhlet extractor for a duration of 12 hours. To evaluate the flexural strength, a three-point bending test was conducted after 24 hours using a universal material testing machine at a crosshead speed of 1 mm/min. **Results:** Dunn's test was conducted as a post hoc comparison, revealing that group 2:1 exhibited the highest median flexural strength (M = 27.2 MPa), followed by group 1:1 with a median of 20.1 MPa. **Conclusion:** The addition of the plant extract at higher concentrations resulted in an improvement in flexural strength.

Keywords: Flexural Strength, Glass ionomer cement, Olea europaea.

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Introduction

Dental caries is a microbiological disease of the teeth's hard structure that causes localized demineralization of the inorganic portion. It needs to be filled or restored with restorative materials to prevent further complications. [1] Dental restoration is used to prevent infection and additional decay in the mouth. One of the motivating factors for dental restoration is to improve smiles and restore confidence. The dental restorations are designed to match the color and size of the natural teeth.[2] Glass ionomer cement (GIC) sets by an acid–base reaction.[3]

The success of dental materials clinically depends on many factors, among which is the good adhesion to the surface of the tooth to resist various dislodging forces.[4] Shear bond strength is known as the resistance to dislodging forces, which causes the sliding of the restorative material against the tooth structure. It adopts much importance to the dentist clinically because it has been proven that the major dislodging forces at the tooth restoration interface have a shearing effect. [5]

Herbal extracts have recently gained even more attention as active agents to be incorporated into oral care products and dental materials. Many of them have potential antimicrobial activities which could lead to the production of safe, economical, and efficient alternative materials for use in caries management. [6] The Iranian herbal medicine with a long history of effectiveness and safety is a rich source of such agents. The use of herbal products is increasing at an exponential rate in both developing and developed countries owing to the free availability, religious beliefs, as well as unique chemical composition. [7] This novel branch has its roots in ancient medicine and the pre-antibiotic era. Herbal extracts were claimed to have the advantage of showing their beneficial effects without the risk of developing microbial resistance. Nowadays, several herbal products are available in the market in different forms, such as toothpastes, oral gels, and mouth rinses. [8,9] Salvadora persica (S. persica) is a small tree that belongs to the family Salvadoracea and is commonly known as miswak (toothbrush) tree. Studies of miswak against oral bacteria such as Streptococcus mutans, salivaris, Staphylococcus aureus, and mitis have proven that the crude extract was significantly effective, with an inhibition zone production of 67 and up to 96%. [10,11] Hence, this study was conducted to evaluate flexural strength of glass ionomer cement modified with phytomedicine.

Materials & Methods:

A total of 40 samples were enrolled. Ethyl alcohol was used to extract leaves from Salvadora persica, and Olea europaea using a Soxhlet extractor for a duration of 12 hours. The resulting plant extract mixture (PE) was then added to water in two different concentrations to prepare a conventional freeze-dried glass ionomer cement (GIC) in

the ratios (extract: water) 1:1, and 2:1. Following the manufacturer's instructions, specimens were prepared and compared against unmodified GIC (control) and GIC modified with 0.5% chlorhexidine. To evaluate the flexural strength, a three-point bending test was conducted after 24 hours using a universal material testing machine at a crosshead speed of 1 mm/min. Statistical analysis was done using SPSS software. The p- value <0.05 was considered significant.

Results:

According to the Kruskal-Wallis H test, the plant extract mixture had a significant impact on the flexural strength of the samples (p-value < 0.001). Dunn's test was conducted as a post hoc comparison, revealing that group 2:1 exhibited the highest median flexural strength (M = 27.2 MPa), followed by group 1:1 with a median of 20.1 MPa. Furthermore, group 2:1 showed statistically significant differences when compared to the control group (M = 11.2 MPa), and the CHX-GIC group (M = 16.4 MPa).These findings suggest that the concentration of the plant extract mixture, particularly in the 2:1 ratio, had a substantial effect on the resulting flexural strength of the tested specimens.

Table 1: comparison of flexural strength values

Variable	Number	Median (MPa)	p- value
Control	10	11.2	<0.001*
CHX-GIC	10	16.4	
1:1	10	20.1	
2:1	10	27.2	

*Significant at p<0.05

Discussion:

Innovations in dental material science are come to the point of developing smart materials.[12] Glass-ionomer cement (GIC), a tooth-colored acid-base material, with the capability of fluoride release in an aqueous environment is the first of this category. [12,13] It can be used as base, liner, or direct restorative material and is also considered as the material of choice in atraumatic restorative technique (ART). The ART is a minimal intervention approach, particularly beneficial for pediatric and elderly patients as well as those with dental anxiety or learning difficulties. [13] Hence, this study was conducted to evaluate flexural strength of glass ionomer cement modified with phytomedicine.

In the present study, according to the Kruskal-Wallis H test, the plant extract mixture had a significant impact on the flexural strength of the samples (p-value < 0.001). Dunn's test was conducted as a post hoc comparison, revealing that group 2:1 exhibited the highest median flexural strength (M = 27.2 MPa), followed by group 1:1 with a median of 20.1 MPa. Another study by Singer L et al, there were no statistically significant differences between the control (M = 20.5%), CHX-GIC (M = 19.6%), 1:1 (M = 20.0%), 1:2 (M = 19.5%), and 2:1 (19.7%) groups with regard to the percentage of water sorption, while for water solubility the 2:1 (M = -0.39%) plant-modified group was significantly different from all of the other groups. Flexural strength test results showed that the 2:1 group (M = 26.1 MPa) recorded significantly higher mean values compared to all other tested groups. The plant extracts did not negatively affect the water sorption and solubility of the GIC, while the flexural strength was improved by the addition of the plant extract at higher concentrations. [14]

In the present study, furthermore, group 2:1 showed statistically significant differences when compared to the control group (M = 11.2 MPa), and the CHX-GIC group (M = 16.4 MPa).These findings suggest that the concentration of the plant extract mixture, particularly in the 2:1 ratio, had a substantial effect on the resulting flexural strength of the tested specimens. Another study by Shahriari S et al, the mean diameter of the inhibition zones are significantly different among the test groups and also the test groups and the control group except for the group with 0.5% in L. casei category which shows no significant difference with the control group. They revealed direct inhibitory activities of S. officinalis-containing GIC against S. mutans and L. casei in a dose-response manner. [15] Hook et al. proposed a GIC functionalized with chlorhexidine-hexametaphosphate particles. The suggested material released chlorhexidine in a dose-dependent manner and showed to have antimicrobial properties. [16] In

another study, de Castilho et al. added doxycycline hyclate as an antibiotic with local antimicrobial and antimatrix metalloproteinase activities into the GIC. The modified material showed inhibitory effects on caries producing bacteria. [17] Deepalakshmi et al. incorporated chlorhexidine and cetrimide as wide-spectrum antiseptics into GIC and developed an antibacterial material. [18] Despite the common usage of glass ionomer cement (GIC) in dentistry because of the anticariogenic property, fluoride release, and rechargeability, the reduction in the bacterial counts and the ability of the conventional glass ionomer cements to completely arrest the caries process is still not reliable for many clinical situations. Therefore, many investigations are concerned with improving the antibacterial activity of GIC to overcome this problem. [19,20]

GIC modified with S. persica, F. carcia, and O. eoropaea extract mixtures has shown significant antimicrobial activity against S. mutans before, which is the main causative organism of dental caries and M. luteus, which is a sensitive marker to the release of antimicrobial agents. [21]

Conclusion:

The addition of the plant extract at higher concentrations resulted in an improvement in flexural strength. Specifically, the group with a higher concentration of the plant extract mixture (2:1 ratio) exhibited the highest flexural strength among the tested groups, indicating that increasing the concentration of the plant extract had a positive impact on the overall strength of the specimens.

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